# DISSERTATION ON

**The Use of Fibular plating as supplementary technique in static intramedullary interlocking nailing for distal both bone fractures of leg - A Prospective Study**

*Submitted to*

**THE TAMILNADU**
**DR. M.G.R. MEDICAL UNIVERSITY**
**CHENNAI, TAMILNADU**

*As fulfillment of the regulations*
*for the award of the degree*

**M.S. (ORTHOPAEDIC SURGERY)**
**BRANCH II**

**GOVT. KILPAUK MEDICAL COLLEGE**
**CHENNAI**

**MARCH 2010**

# CERTIFICATE

Certified that the dissertation on **"The Use of Fibular plating as a supplementary technique in static intramedullary interlocking nailing for distal both bone fractures of leg - A Prospective Study"** is a bonafide work done by Dr.R.Selva Renga Raju, Postgraduate, Department of Orthopaedic Surgery, Kilpauk Medical College & Hospital, Chennai – 10, under my guidance and supervision in partial fulfillment of the regulation of The Tamilnadu Dr.M.G.R. Medical University for the award of M.S. Degree Branch II (Orthopaedic Surgery) during the academic period of may 2007 – March 2010.

**Prof.K.Sankaralingam,**
**D.Ortho,M.S.(Ortho),DNB(Ortho)**
Additional Professor of Orthopaedics
Kilpauk Medical college and Hospital
Chennai- 600010

**Prof.K.Nagappan,**
**D.Ortho,M.S.(Ortho),**
Professor and Head of Dept
of orthopaedics,
Kilpauk Medical College
Chennai- 600010

**Prof.Dr.V.Kanagasabai,M.D**
The Dean
Kilpauk Medical college and Hospital
Chennai – 600010

# DECLARATION

I declare that this dissertation entitled **“The Use of Fibular plating as a supplementary technique in static intramedullary interlocking nailing for distal both bone fractures of leg - A Prospective Study”** has been conducted by me at the Department of Orthopaedic Surgery, Kilpauk Medical College & Hospital, Chennai, under the guidance and supervision of my respected Chief Prof. K. Sankaralingam, D. Ortho, M.S. (Ortho), DNB (Ortho), Government Kilpauk Medical College and Hospital, Chennai. It is submitted as a part of fulfillment of the award of the degree in M. S. (Ortho), for the March 2010 examination to be held under The Tamilnadu Dr. M.G.R. Medical University, Chennai. This has not been submitted previously by me for the award of any degree or diploma from any other university.

**Dr.R.Selva Renga Raju**

## ACKNOWLEDGEMENT

I wish to express my sincere thanks to our Dean **Prof.V. Kanagasabai M.D.,** Kilpauk Medical College, Chennai, for having allowed me to conduct this study.

It is my proud privilege to express my sincere thanks to my beloved and kindhearted Chief **Prof. K. Sankaralingam D. Ortho., M.S. (Ortho)., DNB(Ortho).,** Additional Professor of Orthopaedics, Kilpauk Medical College and Hospital, for his total support in all my endeavors.

I wish to express my sincere thanks and gratitude to **Prof. K. Nagappan D.Ortho., M.S. (ortho).,** Professor and Head, Dept. of Orthopaedics, Kilpauk Medical College & Hospital. He was an immense source of inspiration and guidance during my study.

I wish to express my sincere gratitude and heartfelt thanks to **Prof. K.V.Chandrasekaran D. Ortho., M.S (Ortho).**, Additional Professor of Orthopaedics, Kilpauk Medical College and Hospital, for his encouragement.

I wish to express my heartfelt thanks to **Prof. N.O. Samson Jebakumar D.Ortho., M.S (Ortho).,** Additional Professor of

Orthopaedics, Kilpauk Medical College and Hospital, for his kind support.

I am deeply indebted to **Dr. R.Samuel Gnanam D.Ortho, M.S (Ortho), Dr. K.**

**Raju D. Ortho, M.S (Ortho), Dr. V. Singaravadivel D.Ortho, M.S (Ortho), Dr. S. Veerakumar M.S (Ortho), Dr. R. G. Mohan M.S(Ortho),Dr.Thanigaimani M.S (Ortho),Dr.S.Sukumaran. D. Ortho, M.S (Ortho), Dr.G.Baskar D. Ortho,** Assistant Professors of our department for their immense help, continuous motivation, expert guidance and timely advice during the course of my study and for the prepration of this dissertation.

Last but not least I sincerely thank all the patients involved in this study. Their co-operation and endurance has made this study a worthy one.

# CONTENTS

# INTRODUCTION

Treatment of distal both bone fractures of leg remains a challenge. The goals of surgical management include correction and maintenance of sagittal and coronal alignment, establishment of length and rotation and early functional range of movements of knee and ankle.

Treatment options include medullary implants, half pin, thin wire or hybrid external fixation, plate fixation or combination techniques.

Interlocking nailing of tibial fractures are desirable because this technique allow some load sharing , spares extraosseous blood supply, avoids extensive soft tissue dissection and is familiar to most surgeons.

Nailing of distal tibial fractures with short distal fragment is associated with an increase in malalignment particularly in coronal plane, non union and need for secondary procedures to achieve union. The cause has been attributed both to displacing muscular forces and residual instability.

As there is a mismatch between the diameters of the nail and the medullary canal, with no nail-cortex contact, the nail may translate laterally along coronally placed locking screws and increased stress in placed on the locking holes to maintain fracture alignment after surgery.

Various techniques have been recommended to improve nailing the distal both bone fractures of leg including fibular plating (distal third fractures), temporary unicortical plating, different nail design with different proximal bends (proximal third fractures) and blocking screws (poller screws)

# AIM

To evaluate the clinical use of fibular plating as a supplement to stability in addition to intramedullary nailing in distal both bone fractures of leg.

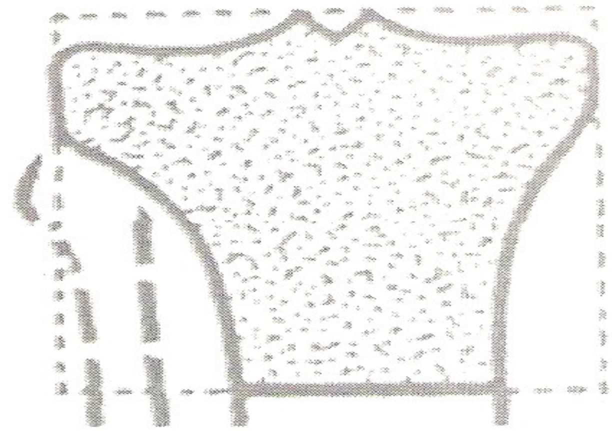
# DISTAL BOTH BONE FRACTURES (METAPHYSEAL) OF LEG

**Anatomy of Tibia**

Shaft of tibia is triangular in cross section. Shaft of tibia expands at both the upper and lower ends to support body's weight at the knee and ankle joints.

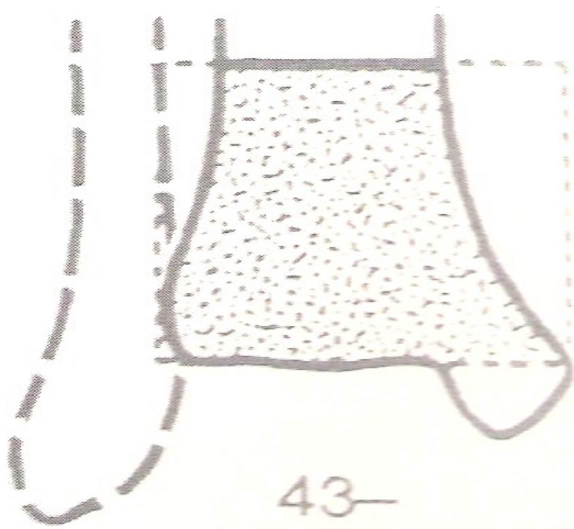
Distal end of tibia is shaped like a rectangular box with a bony protuberance on the medial side ( medial malleolus )

Metaphyseal zone of proximal tibia



41–

Metaphyseal zone of distal tibia



43–

## ANATOMY OF FIBULA

The fibula is the lateral and smaller bone of the leg.The tip of the lateral malleolus (distal seven cm of fibula) is 0.5 cm lower than that of medial malleolus.The lateral malleolus and the ligaments attached to it are very important in maintaining stability at the ankle joint

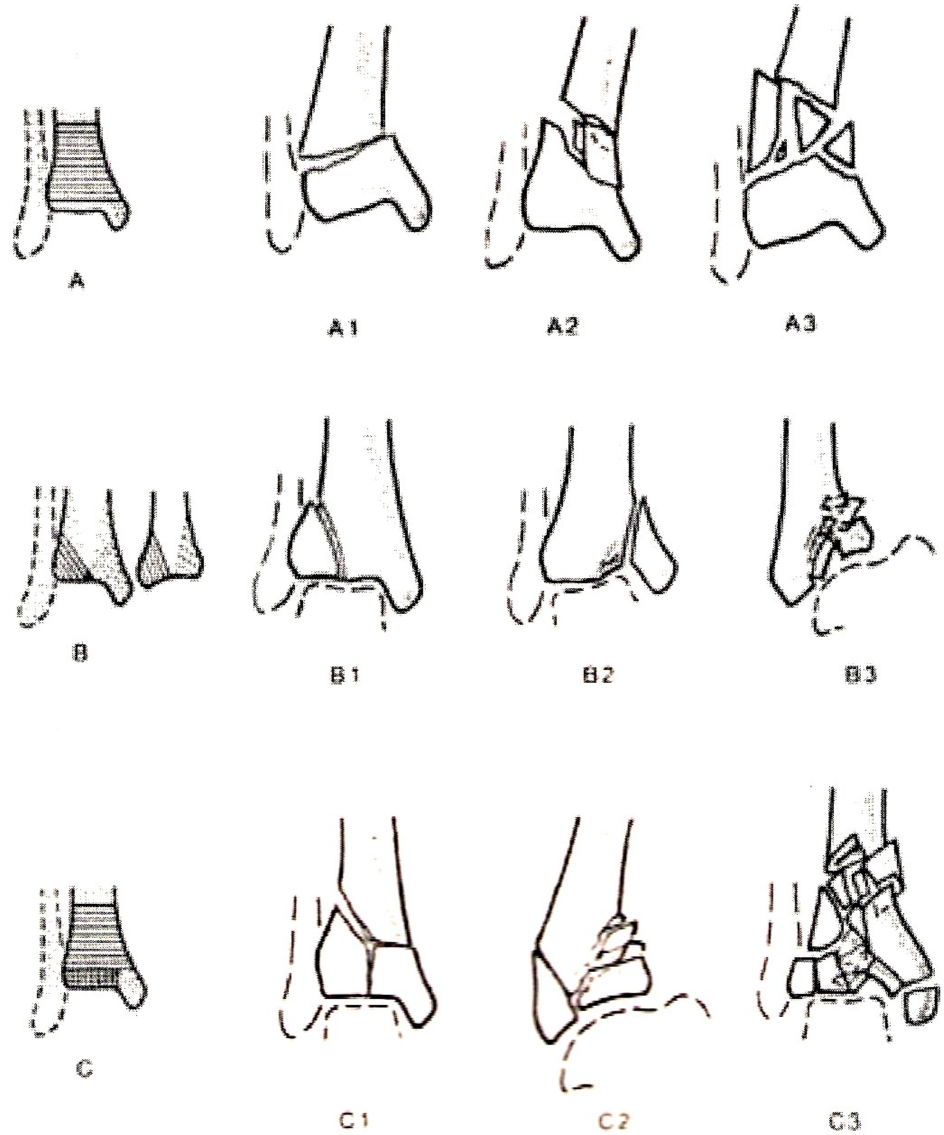
### Metaphyseal fractures of tibia

### Definition

Metaphyseal Zone is defined as the area within a square the sides of which are the same length as the widest part of the articular surface.

## Classification

AO/OTA Classification of Distal Tibial Metaphysis



## 1. AO/OTA Classification

According to AO/OTA classification metaphyseal fractures of tibia and fibula in the proximal end is designated as 41 and in the distal end as 43.The malleolar segment is an exception is classified as the fourth segment of the tibia/fibula (44). Type A is extra articular, Type B is partial articular type C is complete articular.

**AO/OTA Classification of Proximal Tibal Metaphysis 41**

A – Extra articular fracture

A1 – Extra articular, avulsion

1. Of the fibular head
2. Of the tibial tuberosity
3. Of the cruciate insertion

A2 – Extra articular fracture, Metaphyseal simple

1. Oblique in frontal plane
2. Oblique in sagittal plane
3. Transverse

A3 – Extra articular fracture, Metaphyseal multifragmentary

1. Intact wedge

2. Fragmented wedge
3. Complex

B – Partial articular fracture

B1 – Partial articular fracture, Pure split

1. Of the lateral surface
2. Of the medial surface
3. Oblique, involving the tibial spines and one of the surfaces

B2 – Partial articular fracture, Pure depression

1. Lateral total
2. Lateral limited
3. Medial

B3 – Partial articular fracture, split depression

1. Lateral
2. Medial
3. Oblique, involving the tibial spines and one of the surfaces

C – Complete articular fracture

C1 - Complete articular fracture, Articular simple, Metaphyseal simple

1. Slight displacement

2. One condyle displacement

3. Both condyles displacement

C2 – Complete articular , Articular simple, Metaphyseal multifragmentary

1. Intact wedge

2. Fragmented wedge

3. Complex

C3 – Complete articular fracture, multifragmentary

1. Lateral

2. Medial

3. Lateral and Medial

AO/OTA Classification of Distal Tibial/fibular Metaphysis 43

A – Extra articular fracture

A1 – Extra articular, Metaphyseal simple

1. Spiral

2. Oblique

3. Transverse

A2 - Extra articular fracture, Metaphyseal wedge

1. Posterolateral impaction
2. Anteromedial wedge
3. Extending into the diaphysis

A3 – Extra articular fracture, Metaphyseal complex

1. Three intermediate fragments
2. > 3 intermediate fragments
3. Extending into the diaphysis

B – Partial articular fracture

B1 – Partial articular fracture, Pure split

1. Frontal
2. Sagittal
3. Metaphyseal multifragmentary

B2 – Partial articular fracture, Split depression

1. Frontal
2. Sagittal

3. Of the central fragment

B3 – Partial articular fracture, Multifragmantary depression

1. Frontal

2. Sagittal

3. Metaphyseal multifragmentary

C – Complete articular fracture

C1 – Complete articular fracture, Articular simple, Metaphyseal simple

1. Without depression

2. With depression

3. Extending into diaphysis

C 2 – Complete articular, Articular simple Metaphyseal multifragmentary

1. With asymmetric impaction

2. With depression

3. Extending into diaphysis

C3 – Complete articular fracture, multifragmentary

1. Epiphyseal

2. Epiphyseo - metaphysis

3. Epiphyseo - metaphyseo – diaphyseal

2. **Taylor and Martin SUD classification** of metaphyseal fractures

Taylor and martin proposed a classification of metaphyseal fractures (SUD) in which the main fracture is characterized as stable (S), unstable (U) or with diaphyseal extension (D). These are furthur divided into three subtypes.

Taylor and Martin SUD classification of metaphyseal fractures

S – Stable

S.0 - extra articular

S.1 -<2mm displacement

S.2 ->2mm displacement

U – Unstable

U.0 - extra articular

U.1 -<2mm displacement

U.2 ->2mm displacement

D – Diaphyseal Extension

D.0 - extra articular

D.1 -<2mm displacement

D.2 ->2mm displacement

According to Taylor and Martin with progression from type S to type D, treatment shifts towards external fixator and away from open reduction. Conversely with progression from subgroup 0 to subgroup 2 open reduction is indicated.

## Treatment options

### Conservative treatment

Conservative management of distal both bone fractures of leg resulted in significantly high rate of complications. Sarmiento et al in 1989 concluded that bracing was contraindicated in fractures with excessive initial shortening or ones showing increasing angular deformity while in cast. Most series of closed treatment have reported 25 to 40% incidence of ankle and subtalar joint stiffness after prolonged casting and immobilisation.

### Plates and screws

Open reduction and plate fixation of tibia is also associated with a high incidence of soft tissue complications in the range of 10 to 15% in many series. But the recent advances in plating techniques and designing have reduced these complications significantly. Indirect reduction and percutaneous plating (LISS – Less Invasive stabilization System) is indicated in a tibial shaft fracture with periarticular metaphyseal comminution that precludes the use of standard incisions according to Collinge and Sanders.

**Hybrid fixator**

Thomas A Russell preferred hybrid fixator or plate & screw technique with open and indirect reduction technique in metaphyseo diaphyseal transition or metaphyseal unstable fractures of distal leg.

Bono CM et al proposed a treatment algorithm for proximal tibial fractures with minimal or severe soft tissue injury, He preferred external fixation when the distal fragment is too short and nailing only when it is long.

**Locked compression plate**

Introduction of locked compression plate has changed the plating technique and the outcome in metaphyseal fractures significantly.

Though the locked compression plate with MIPO(Minimally Invasive Plate Osteosynthesis) technique eliminates the soft tissue problems associated with open reduction and internal fixation, it cannot help in fracture reduction. The fracture alignment has to be restored before applying the locked compression plate.

In the treatment of distal tibial fractures, locked compression plates provide more stable fixation than intramedullary nailing in vertical loading but were less effective in the cantilever bending . In fracture patterns, in which the fibula cannot be effectively stabilized, locked plates offer improved mechanical stability when compared with locked nails alone. In this study fibular plating is done as a supplementary procedure in the nailing group to improve the stability.

**Disadvantages of locking compression plate in distal tibial metaphyseal fractures.**

1. Soft tissue complications in conventional open reduction and plating of tibia
2. Development of superficial wound problems increased the risk of deep infection six fold.
3. Malalignment is more frequent in percutaneous plating than with the other methods of fixation.
4. Fracture alignment could not be aided by the locked plate (no lag effect through the plate). It has to be restored before applying the plate.
5. Locked compression plating needs careful preoperative planning. If applied without following the principles of plating and the order of putting the screws, failures are not uncommon.
6. Late pain over the distal tibial plate and screws.

**Poller screws**

Poller screws placed adjacent to the nail and perpendicular to the screw holes usually in an anteroposterior direction has been found to improve the stability of distal tibial metaphyseal fractures.

# LITERATURE REVIEW

## Evolution of interlocking nailing

Evolution of intramedullary nailing dates back to 500 years ago, it was recorded that Aztecs used wooden intramedullary nails.

In 1916 Kuntscher introduced cannulated nails for tibia and femur. In 1950, Lottes one of the pioneers in tibial nailing developed a rigid nail for tibia.

In 1951 Herzog modified the Kuntscher nail, by adding a proximal bend to falicitate nail insertion.

Modney is credited with designing the first interlocking nail.

Kuntscher also designed an interlocking nail (The Detensor nail, 1968) which was then modified by Klemm Schellumm initially and by Kempf and Crosse later in 1972.

In 1986 Bone & Johnson were the first to report interlocking nail in united states. They used Grosse Kempf interlocking tibial nail in fractures of tibial shaft.

Charnley in his text "closed treatment of common fractures" stated that he believed the eventual solution to the tibial shaft fracture would be a non reamed intramedullary nail.

A fracture zone 5cm below the knee and 5cm above the ankle was required for effective use of interlocking nail. As the fracture line extend into the metaphyseal zones of the tibia, the stability provided by any nail decreases precipitously.

**Intramedullary nailing in tibial metaphyseal fractures**

Closed, locked intramedullary nailing is widely accepted as satisfactory treatment for tibial diaphyseal fractures. But there are concerns about the use of this technique for fractures in distal metaphysis.

Various supplementary procedure were used by different authors to effectively manage the metaphyseal fractures of tibia with intramedullary nailing .

**Proximal tibial metaphyseal fractures**

In 1996 Tornetta P III advocated semiextended position to prevent anterior translation and antecurvatum.

In 1997 Buchler et al and Tembcke et al suggested lateral entry point to prevent varus deformity.

In 2003 Laflamme et al proposed more oblique screws to maintain the alignment.

In 2006 Sean E Nork suggested temporary unicortial plating to achieve alignment.

Laflamme et al and Sean E Nork explained the wedging effect, when the proximal bend is distal to the fracture site. Hence they used nails with more proximal bend.

**Distal tibial metaphyseal fractures**

**Poller screws**

Poller screws placed adjacent to the nail and perpendicular to the screws holes usually in an anteroposterior direction had been suggested as one possible method of improving the stability of metaphyseal fractures and had been described as a reduction tool used to over come the displacing forces at the time of introduction of intramedullary nail.

The poller screws functionally decrease the width of the metaphyseal medulla and are particularly useful with nails of smaller diameter.

In 1994 Krettek et al described the clinical application of blocking screws, termed poller screws as a tool for the prevention of axial deformities of proximal and distal third fractures of tibia during intra medullary nailing. The same technique has been used for femoral fractures too.

In 1995 Robinson et al used percutaneous large reduction forceps to achieve the alignment and maintain the same throughout the nailing procedure. He also resected the distal few millimeters of the standard AO nail to nail the 4cm length distal metaphyseal fragments and used the distal locking bolts as lag screws through the fracture site.

In 1997 Thompson KA et al and Weber TG et al showed excellent results when supplemented with fibular plating. In 2000 Tyllianaki also found fibular plating as an effective supplement.

In2002 Goezyca et al published their results of modified tibial nails for the distal metaphyseal fractures.

In 2003 James Kellam stated that fibular plating or poller screws were effective as supplementary techmiques in intramedullary nailing of distal tibial metaphyseal fractures.

In 2005 Sean E Nork et al compared the results of those treated with nailing alone and those treated with supplementary fibular plating.

In 2006 Kenneth A Egol et al advocated fibular plating and temporary unicortial plating.

**Fibular plating**

Fibular plating has been found to be an excellent supplementary technique to intramedullary interlocking nailing in distal both bone fractures of leg as it helps in reduction and alignment peroperatively especially in fresh fractures and helps in maintaining fracture alignment till union,preventing loss of initial reduction.

**Pathophysiology of intramedullary nailing**

**Nailing without reaming**

Smaller diameter implants are used in nail insertion without reaming

The benefits are less heat production and less disturbances of the endosteal blood supply.

There is also considerably less bone necrosis, which appears to be one of the risk factors for the development of post operative infection.

The influence of nail diameter on blood perfusion and mechanical parameters studied in dog models by Hupel TM et al. Following segmental osteotomy of the tibia, it was shown that a loose fitting nail did not affect cortical perfusion as much as right fitting nail and it allowed more complete cortical revascularization at 11 weeks post nailing. On the other hand stiffness and load to failure were not found to be different.

**Nailing with reaming**

Nailing with reaming produces various local and general changes in the body.

**Local Changes**

Reaming the medullary cavity causes damage to the internal cortical blood supply, which in animal experiments was shown to be reversible within 8-12 weeks. This reduced blood supply during the early weeks after trauma and reaming might account for the increased risk of infection, especially in open tibial fractures. Because of infection rates as high as 21%, the use of reamed intramedullary nails in open fractures, even on a delayed basis, was not recommended.

**General Changes**

These include pulmonary embolism, temperature related changes of the coagulation system and humoral, neural and inflammatory reaction.

The development of post traumatic pulmonary failure following early femoral nailing in the multiple injured patients is associated with the reaming procedure.

Wenda et al measuring intramedullary pressure intra operatively, found values between 420 – 1510 mm Hg with reaming procedures, as compared with 40 – 70 mm Hg in cases where used without reaming.

## MAIN OUTCOME MEASUREMENTS

Alignment and reduction preoperatively, postoperatively and at healing was the main outcome measured with an emphasis on loss of initial reduction on follow up.

# PATIENTS AND METHODS

This was a prospective study of 20 cases of distal both bone fractures of leg treated with statically locked intra medullary nailing with supplementary fibular plating between march 2008 and September 2009 at Kilpauk Medical College.

## Inclusion Criteria

Displaced distal third both bone fractures of leg in adults treated with intramedullary nailing were included in this study .

The fractures included were acute fractures and delayed union.

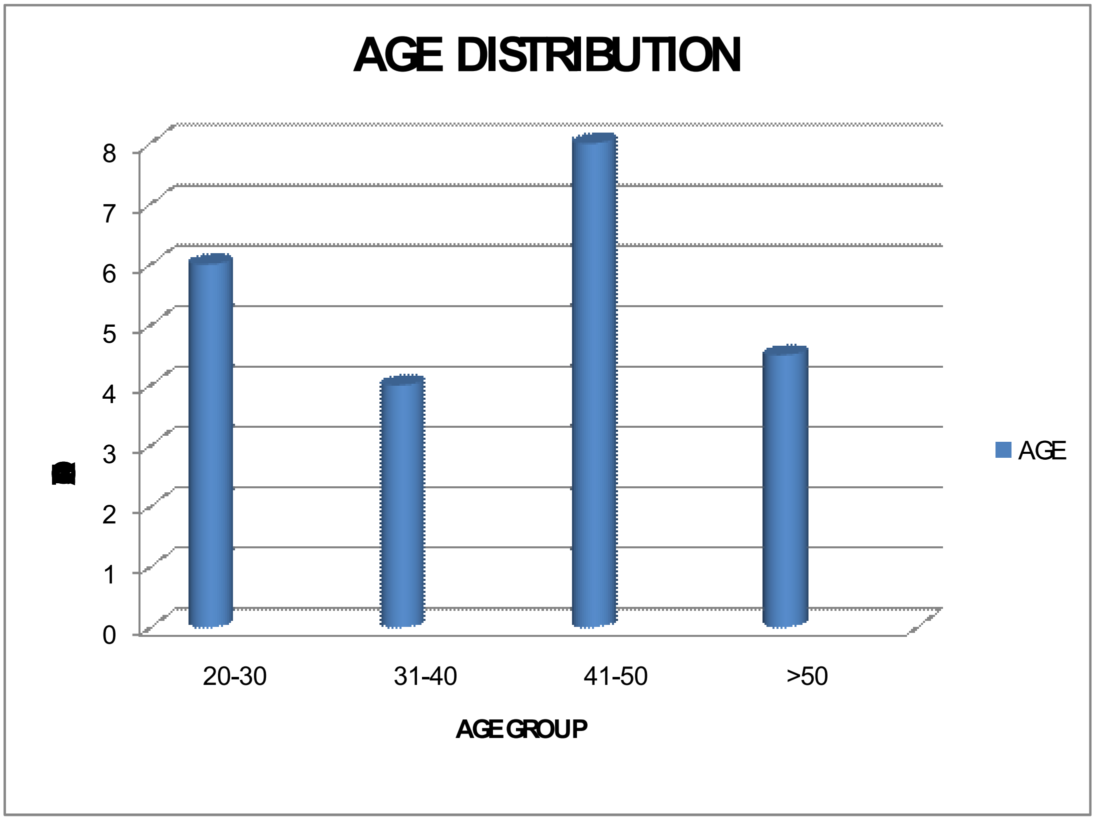
## Exclusion Criteria

Distal tibial fractures with articular extension (pilon fractures)

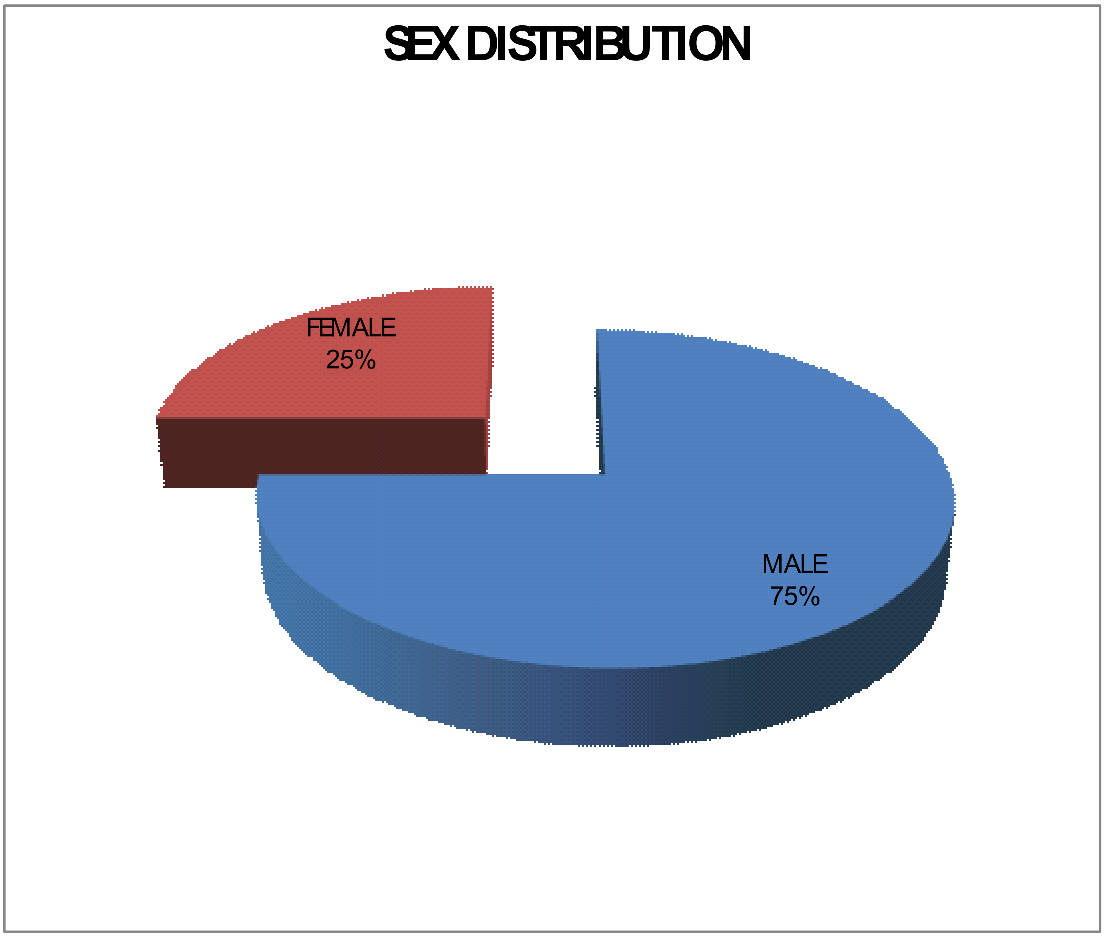
Comminuted fibular fractures

**Patients**

Among the operatively treated tibial fractures between march 2008 and September 2009 at Kilpauk Medical College 20 cases met the inclusion criteria.

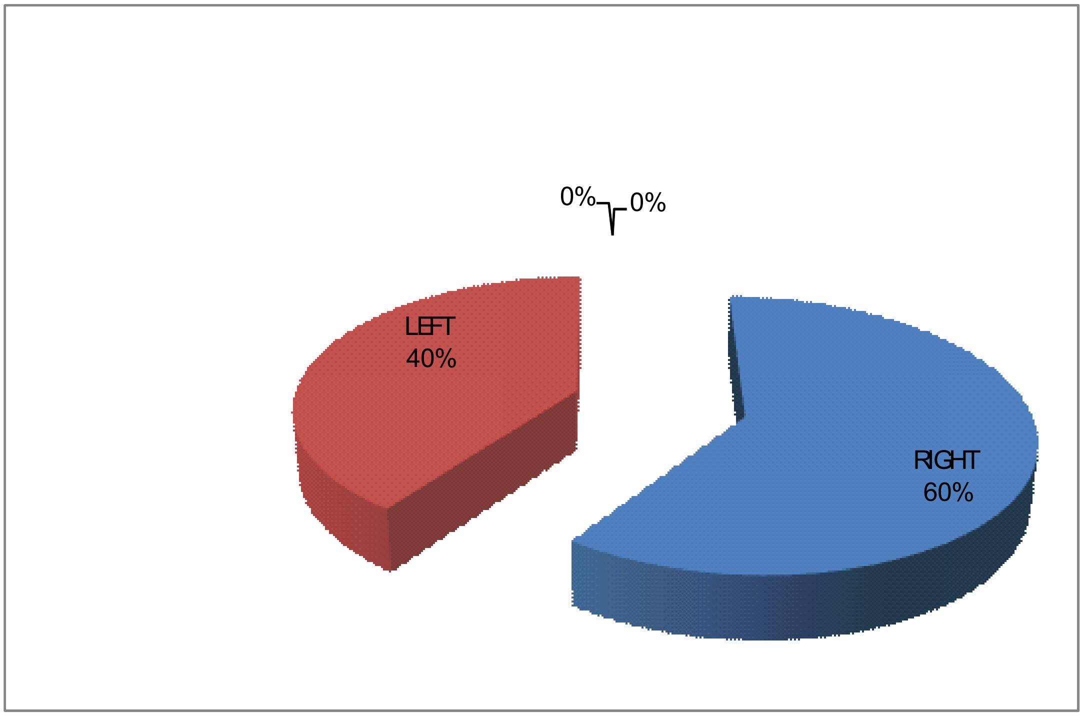



There were 15 males and 5 female patients with a mean age of 36.57 years [95% lower confidence limit of (LCL) 32.87 years and 95% upper confidence limit of (UCL) 41.63].


SEX DISTRIBUTION
FEMALE
25%
MALE
75%

The injury was on the right side in 12 cases.

**SIDE OF INJURY**




The mechanism of injury was Road traffic accident in all except there in whom it was fall from height in two and fall of a heavy object over the leg in one.

Injury was closed in 17 fractures and Gustillo Anderson grade 1 in 3 patients

The mean distance from the articular surface was 5.83 cm (95% LCL 3.79 cm and 95% UCL 6.87 cm) and the mean length of the fractures was 3.4cm (95% LCL 2.55 cm and 5% UCL 4.10cm).

The mean delay between the injury and the surgery was 1.85 weeks (95% LCL 0.78 weeks and 95%UCL 3.64 weeks). Among the 20 cases two were delayed union of 14 weeks duration.

The mean operating time was 85 minutes.

The mean diameter of the medullary canal at the level of isthmus was 12.1 mm and at the fracture site was 22.7 mm.

Medullary canal diameter (in mm)

| | **Mean** | **S.D** | **95% LCL** | **95% UCL** |
|---|---|---|---|---|
| Isthmus | 11.7 | 1.5 | 10.9 | 12.9 |
| Fracture site | 22.3 | 6.4 | 18.9 | 26.1 |
| Distal metaphysis | 49.9 | 3.6 | 47.9 | 50.6 |

**Fibular plating**

Fibular plating was selected for use for one or more of the following reasons

1. To correct alignment before insertion of nail
2. To maintain alignment or to improve the stability of bone implant complex
3. To achieve rotational stability

# OPERATIVE PROTOCOL

## Pre operative planning

X ray of the injuried leg in AP & Lateral views taken. The fracture tendency for valgus or varus and antecurvatum or recurvatum malalignment was noted. The angle of malalignment was measured.

Fracture location from the distal articular surface was measured. The length of fracture was also measured. The diameters of medullary canal at isthumus and at the level of fracture were measured.

Approximate length of the nail was measured in the contralateral leg, from the tibial tuberosity to medial malleolus.

## Operative Technique

In this technique,distal both bone fractures of leg were stabilized with statically locked intramedullary nail along with fibular plating on a standard radiolucent table with manual traction.

All the cases were done under spinal anaesthesia. Tourniquet was not used in any case. In all fresh cases,through a posterolateral incision,skin, subcutaneous tissue and fascia incised.Fibular fracture site exposed, freshened and reduced.After achieving the proper alignment and reduction,fibular plating done with appropriate one third tubular plate(usually a six or seven holed plate) and cortical and cancellous screws of different sizes.once proper length and rotation of fibula is achieved,in fresh cases the tibia aligns itself and malalignment in both sagittal and coronal planes could be avoided.In those delayed cases where alignment of fibula does not result in alignment of tibia,open reduction and internal fixation with intramedullary nail is done.

The nails used were cannulated stainless steel nail, with 2 proximal (mediolateral) and 3 distal (2 mediolateral and 1 anteroposterior) locking options, of diameter 8 or 9 mm.

Then through a patellar tendon splitting approach, entry point was made in the midline, progressive reaming done and guide wire was passed under image intensifier control,reduction verified,if not satisfactory fracture site opened tibia reduced and intramedullary nail introduced and locked with one or two proximal screws and two or three distal screws.

Closed reduction was done in fourteen cases. In the remaining cases, closed reduction was attempted and we had to do open reduction as there was a marked overriding of the fragments and difficulty in aligning tibia and achieving reduction or delay of 16 weeks before surgery.

The alignment was confirmed in both coronal and sagittal plane with image intensifier.

**Post operative treatment**

Partial weight bearing was started in second postoperative week in all except three cases. In two cases the distal screw purchase in fibula is poor as it is so osteoporotic, we recommended non weight bearing till radiological evidence of union and in the other case the reduction of tibia was so unstable, partial weight bearing could not be started. In these cases cast support was given for 4 weeks.

Partial weight continued up to 4 to 8 weeks thereafter full weight bearing started depending on clinical and radiological evidence of union.

**Follow up**

All the fractures were followed through till union of fracture with clinical and radiological examination at intervals of 4 to 6 weeks. The maximum follow up was 12 months.

On follow up axial alignment was assessed and functional analysis was quantified using Karlstorm – Olerud score.

Valgus and antecurvatum were expressed as positive values and varus and recurvatum were expressed as negative values.

Radiographs were analyzed for correction, maintenance of position or loss of reduction.

Fracture was defined as united when patient was able to bear full weight on the injured limb without pain and without support and when radiographs showed bridging callus in at least 3 cortices.

**Complications of fibular plating**

Complications were divided into those which were related to fibular plate and those which were not.

Complications related to fibular plate are conventional soft tissue problems in open reduction and fibular plating such as development of superficial wound resulting in skin necrosis ( as a result of extra hardware),which might increase the risk of infection by six fold.

Complications not related to fibular plating per se may be compartment syndrome, breakage of locking screws and tendon or neurovascular injury .In our series we had only two cases of skin problems and deep infection.

## DATA ANALYSIS

Data analysis was done using repeated measures ANOVA test.

Repeated measures designs are popular because they allow a subject to serve as their own control. This improves the precision of the experiment by reducing the size of the error variance on many of the F-tests. In our study since there was no control group repeated measures ANOVA test was chosen.

Within-subject designs are those in which multiple measurements are made on the same individual at different point of times. Here the variable in our study were the angle at the fracture site  measured within the subjects at different point of times.

95% upper and lower confidence limits were preferred over range to express the variables as few extreme values of variables of normal distribution should not mislead the interpretation of analysis.

Karlstorm-Olerud score was used to asses the functional outcome. It is an independent measurement, not influenced by other co-morbid conditions and associated injuries.

**Parameters of Karlstorm- Olerud scoring system were**

1. Residual angulation (0 to 3 points)

| | |
|---|---|
| 0 | -- 0 point |
| 1 to 3 | -- 1 point |
| 4 to 5 | -- 2 points |
| >5 | -- 3 points |

2. Fracture Healing (0 to 3 points)

| | | |
|---|---|---|
| Union | < 12 weeks | -- 0 point |
| Delayed union | > 12 weeks | -- 1 point |
| Delayed union requiring secondary procedures | | -- 2 points |
| Non union | > 6 months | -- 3 points |

3. Cast Support (0 to1 points)

| | |
|---|---|
| No cast support | -- 0 point |
| Cast support | -- 1 point |

**Outcome**

| | |
|---|---|
| 0 & 1 points | Excellent |
| 2 & 3 points | Good |
| 4 points | Satisfactory |
| 5 points | Fair |
| 6 & 7 points | Poor |

# RESULTS

All the relevant data were analysed.

All the fractures eventullay united in a mean period of 11.7 weeks (95% LCL 10.19 weeks and 95% UCL 11.98 weeks).

Karlstrom-Olerud score was excellent in 12 fractures (60%), good in 5 patients (25%) and fair in 2 patients(10%) and poor in 1 patient (5%).

Radiologically the mean post operative varus/valgus alignment was ±1.6 degrees (95% LCL 0.6 degrees and 95% UCL 2.8 degrees) when compared to the mean preoperative varus/valgus alignment of ± 10.2 degrees (95% LCL 8.1 degrees and 95% UCL 12.6 degrees).

The alignment was maintained till union with the mean remaining the same in the coronal plane.

| | **N** | **Mean (in degrees)** | **Standard deviation** |
|---|---|---|---|
| Pre op | 20 | 10.2 | 4.4 |
| Post op | 20 | 1.6 | 2.6 |
| At union | 20 | 1.6 | 2.6 |

Repeated measures ANOVA test showed the F-test value of 43.91 Which is significant as the p value is 0.01(p < 0.5).

The mean post operative antecurvatum/ recurvatum alignment was ± 0.25 degrees (95% LCL - 0.2 degrees and 95% UCL 1.9 degrees) when compared to the mean operative antecurvatum/ recurvatum alignment of ± 7.5 degrees (95% LCL 4.8 degrees and 95% UCL 11.1 degrees). F test value in repeated measures ANOVA is 21.389 with a p value of 0.01(< 0.05) which is statistically significant.

The mean antecurvatum / recurvatum alignment at the time of union was ± 0.7 degrees, the loss of alignment was not statistically significant.

| | **N** | **Mean (in degrees)** | **Standard deviation** |
|---|---|---|---|
| Pre op | 20 | 7.5 | 7.1 |
| Post op | 20 | 0.3 | 0.7 |
| At union | 20 | 0.4 | 0.8 |

The mean ratio of fracture segment to the nail length (i.e the length of tibia) was 16%

The fibular plate related complications were encountered in two cases where we had skin necrosis and deep infection,which needed aggressive antibiotic therapy and those patients were also given cast support for twelve weeks. But the alignment was achieved and maintained and the fracture united within 18 weeks.

No complication of tendon injury or compartment syndrome were encountered. There were no incidences of breakage of nail,fibular plate locking screws.

# DISCUSSION

Fracture union was rather difficult to define and measure. Sarmiento et al in 1984 specified criteria for the judgment of union.

1. The ability of the patient to bear weight without pain.

2. Absence of clinically detectable movements across the fracture site.

3. Visible bridging callus across the fracture on plain radiograph.

In case of operative treatment this criteria doesn't hold good. Panjabi et al in 1985 proved that cortical continuity was the best predictor of mechanical strength and the author suggested that measurement of number of cortices bridged was the most reliable measure to assess fracture healing.

In our series, the union was defined as achieved when the patient was able to bear weight in the injured leg without pain and when the radiograph showed bridging callus in at least three cortices.

We cannot over emphasize the potential advantages of intramedullary nailing than any other form of fixation like external fixator or plating in tibial factures. But the problems in extending the indication to metaphyseal fractures have to be analysed and resolved.

In 1996 lesch GJ et al questioned the use of inter locking nailing in distal third both bone fractures of leg in his review of 38 cases. He encountered 79% of malunion i.e. angulations of 5 degrees or more in frontal or sagittal plane and required secondary procedures to achieve in 38 % of cases. Hence he suggested alternate forms of fixation like supplementary fibular plate or external fixation.

Jen Nork et al, in their review started that previously reported rates of unacceptable alignment after medullary nailing of distal third both bone fractures have ranged from 54% to 86%.

Ahlers and Von Issendorf analysed 386 fractures of tibia treated by intra medullary nailing of which 32 were proximal and 138 were distal third fractures. In both the groups one quarter to one third had varus- valgus deformities greater than 4 degrees.

In another study, Moshieff in 1999 found that 42 % of distal third fractures treated with inter locking nailing required secondary procedures to achieve union.

There has been discrepancy in the literature regarding the locking bolt orientation and its effect on fracture nail construct stability.

Chen AL compared the intrinsic stability in tibial intramedullary nail construct is distal third disphyseal fractures without isthmal support, between two mediolateral distal locking screws and two perpendicular (one medio lateral & one antero posterior) distal locking screws. He concluded that fixation stability of intramedullary nail is not significantly influenced by distal locking screw orientation in response to sagittal, coronal or rotational forces.

In contrary, Smucker et al found two parallel locking bolts being a better construct that perpendicular locking bolts in their study.

To overcome these issues various techniques have been developed.

In distal third both bone fractures of leg and slight medial entry point was suggested by Buehler KC et al and Lembcke O et al.

Modifications in nail designs including different proximal bends and more oblique screws have also been put forth as effective solutions.

In distal third fractures fibular plating and cutting the distal few millimeters of nail distal to the distal screws hole to allow two cross locking screws in the distal fragment, one cross screw across fractures site as lag screw and use of large reduction forceps and temporary unicortical plating, percutaneous manipulation with Shanz pins, femoral distractor have been the supplementary procedures used to achieve the alignment.

The amount of malalignment and shortening considered acceptable is controversial. Tarr et al and Puno et al demonstrated that distal tibial mallignment may be more poorly tolerated than more proximal malalignment.

Trafton's recommendation is generally agreed by many authors. As per Trafton's recommendation the acceptable malalignment is less than 5 degrees of varus- valgus angulation, 10 degrees of anteroposterior angulation, and 10 degrees of rotation and 15mm of shortening. In our study we encountered malalignment in three cases of distal third fractures(15%).

**Criteria traditionally used to diagnose a tibial malunion**

**(After Lindsey & Blair 1996)**

| **Authors** | **Varus** | **Valgus** | **Anterior / Posterior** |
|---|---|---|---|
| Bone & Johnson, 1986 | | 5 | |
| Bostman 1983 | 5 | 5 | |
| Collins et al 1990 | 5 | 5 | 5-10 |
| Haines et al 1984 | 4 | 4 | |
| Jensen et al 1977 | 8 | 8 | 15 |
| Johner & Wruh 1983 | 5 | 5 | 10 |
| Nicoll 1964 | 10 | 10 | 10 |
| Puno et al 1991 | 10 | 10 | 20 |
| Trafton 1988 | 5 | 5 | 10 |

## Effect of malunion

Importance of achieving anatomical reduction in fractures of tibia cannot be over emphasized.

Merchant and Dietz in 1989 suggested that for tibial fractures, deformity of >5 degrees was associated with radiographic changes in the ankle.

Van der Schoot reported a 15 year follow up of 88 patients with fractures of lower leg. 49% had healed with malalignment of at least 5 degrees. More arthritis was found in the knee and ankle adjacent to fracture than in comparable joints of the uninjured leg. Malaligned fractures showed significantly more degenerative changes.

Puno RM et al recorded the long term effects of tibial angular malunion of knee and ankle joints in his 28 tibial fractures with an average follow-up of 8.2 years. His analysis showed that greater degrees of ankle malalignment produce poorer clinical results.

Kyro A in his series of 64 tibial shaft fractures concluded that malunion of tibial shaft fractures seem to be especially harmful in distal fractures, in fractures with marked previous displacement, in fractures caused by high energy injury and among patients less than 45 years of age.

We have analysed the mismatch between the diameters of medullary canal at the level of isthmus (i.e. maximum possible nail size ) and at the fracture site in all cases.

We found that there was a significant $p = 0.01(p < 0.5)$ mismatch between them. The diameter of medullary canal at the level of isthmus was 11.7 mm compared to 22.3 mm at the level of fracture site. The mismatch explained the cause of instability in metaphyseal fractures when treated with intramedullary nailing.

We have also measured the maximum diameter of the metaphyseal segment at distal tibia, there by the length of the distal metaphyseal segment was 5.2 cm.

The primary aim of the study was to analyze the effectiveness of achieving and maintaining reduction in distal both bone fractures of leg treated with intramedullary nailing using supplementary fibular plating .

As described in various literatures the malalignment in these circumstances were significantly high when done without any supplementary procedures.

James Kellam in his commentary and perspective on the effect of fibular plate fixation on stability of simulated distal tibial fractures treated with intramedullary nailing by Anand Kumar et al concluded that meticulous intramedullary techniques combined with use of fibular plate fixation or blocking screws will achieve the best results in maintaining the reduction of distal tibial fractures till union.

Kenneth A Egol compared the loss of alignment in distal metaphyseal fractures treated with intra medullary nailing alone. They had immediate post operative malalignment in three cases in those treated with nailing alone, which were eventually corrected by using fibular plating or poller screws.

Tyllianakis in his retrospective review of intramedullary nailing in distal tibial fractures showed excellent results in 86% of patients.In their study,they fixed the concomitant lateral malleolar fractures and if not fixed they used plaster.They noted that patients with concomitant fibular fractures treated with plasters showed permanent swelling and stiffness.They also noted that fixation of fibula helped to align the tibial fracture and facilitate nail insertion.

Richter in his prospective study of distal tibial fractures stabilized with undreamed nailing noted a rate of complications in in distal fractures of fibula without additional plating of fibula.They recommended additional plating for distal fibular fractures.

Moscato and his colleagues recommended fibular plating to ensure overall alignment in supramalleolar fractures.the lateral malleolar fractures when associated with the tibial fractures can lead to incongruity of the ankle joint which may lead to post traumatic arthritis.

A.Bedi,T.T.Lee and M.A Karunakar in their studies proved that in patients with ipsillateral distal tibial and fibular fractures who are treated with Russel and Taylor intramedullary nailing of tibia,rotational stability of the tibial fracture can be increased by plate and screw fixation of the fibula,which may reduce the risk of varus/valgus malunion.

Fibular plating improved the stability of the metaphyseal fractures after nailing and promoted union in our study.

No cases required bone grafting, bone marrow injection or exchange nailing.

The ratio of short metaphyseal fragment to the total tibial length was analysed.The total length of the tibia was approximately derived from the length of the nail used.

The mean ratio was found to be 16%.

Even such short metaphyseal fragments had been effectively stabilized till union with intramedullary nailing when supplemented with fibular plating.

The proportion of fractures that lost alignment were minimal among those receiving stabilization of the fibula in conjunction with intramedullary nailing in many studies as compared with those receiving intramedullary nailing alone.

The reduction should be ensured in two planes with image intensification after placing the fibular plate and before applying the tibial locking screws.

Paige Whittle A and George W Wood II in their analysis of influence of fibular fractures on maintaining the alignment in 40 distal tibial fractures treated with locked intra medullary nailing concluded that 60% of unfixed fibular fractures occurring at the same level as the tibial fractures, were malaligned.

We found that interlocking nailing when supplemented with fibular plating did influence the stability or the functional outcome.

When compared to other techniques described for preventing metaphyseal malalignment during nailing in distal both bone fractures of leg, fibular plating is not technically demanding, do not require any special instrumentation and do not need any special design modification in the nail. There is no significant increase in radiation exposure for applying fibular plating.

In our series the mean ratio of fracture segment to the tibial length was only 16% which denotes that even such short fracture segments can be safely and effectively managed by intramedullary nailing when supplemented with fibular plating in distal both bone fractures of leg .

We had excellent to satisfactory outcome in 85% by Karlstorm-Olerud scoring which is comparable to the results of studies conducted by Tyllianikis el al with 86% excellent to satisfactory.

# CONCLUSION

We conclude that fibular plating, when supplemented the intramedullary nailing of distal both bone fractures of leg,

1. Were effective in achieving the fracture alignment especially in fresh fractures.

2. Improves not only angular stability but also rotational stability.

3. Maintained the fracture alignment till uni

4. on, preventing loss of initial reduction.

# BIBLIOGRAPHY


1. Kenneth A Egol, Russell Weisz, Rudi Hiebert et al. Does fibular plating improve alignment after intramedullary nailing of distal metaphyseal tibial fractures? J Orthop Trauma 2006,20: 94- 103

2. James Kellam, MD Commentary and prospective on " Effect of fibular plate fixation on rotational stability simulated distal tibial fractures treated with intramedullary nailing by Anantkumar" eJBJS 2003.

3. Weber TG, Harrington RM, Henley MB, Tencer AF.The role of fibular fixation on combined fractures of the tibia and fibula: a biomechanical investigation.

4. Strauss EJ, Alfonso D, Kummer FJ, Egol KA, Tejwani NC. The effect of concurrent fibular fracture on the fixation of distal tibial fractures: a laboratory comparison of intramedullary nails with locked plates. J Orthop Trauma 2007 Mar;21(3):172-7.

5. Richter D, Ostermann PA, Ekkerkamp A, Hahn MP, Muhr G. Ankle para-articular tibial fracture. Is osteosynthesis with the unreamed intramedullary nail adequate? Chirug. 1998 May; 69(5):560-70.

6. Thomas KA, Bearden CM, Gallagher DJ, Hinton MA, Harris MB. Biomechanical

analysis of nonreamed nailing after simulated transverse fracture and fibulectomy. Orthopedics. 1997 Jan; 20(1):51-7.

7. Robinson CM, McLauchlan GJ. McLean IP et al. Distal metaphyseal fractures of tibia with minimal involvement of ankle, classification and treatment by locked intramedullary nailing. JBJS(Br) 1995;77:781-7.

8. Tyllianaki N, Megas P, Giannikar D et al. Interlocking intramedullary nailing in distal tibial fractures. Orthopaedics 2000; 23: 805-8.

9. Van der Schoot DK, Den Outer AJ, Bode PJ et al. Degenerative changes at the knee and ankle related to malunion of tibial fractures. 15- year follow up of 88 patients. JBJS(Br) 1996 Sep; 78(5):722-5.

10. Puno RM, Vaughan JJ, Stetten ML, Johnson JR. Long term effects of tibial angular malunion on the knee and ankle joints. J Orthop Trauma 1991;5(3):247-54.

11. Kyro A. Malunion after intramedullary nailing of tibial shaft fractures. Ann Chir Gynaecol 1997;86(1):56-64.

12. Outcome measures in orthopaedics and orthopaedic trauma, 2nd edition, 2004, 280-83.

13. Mueller ME, Nazarian S, Koch P, Shatzker J, The comprehensive classification of fractures of long bones: Berlin etc, Springer Verlag, 1990.

14. Campbell's Operative orthopaedics 10th edition, 2003: volume 3, 2671-73, 2705,2754-57,2760.

15. Rockwood and Greens Fractures in Adults, 4th edition.1996: volume2, 2140-41, 2155-61.

16. Digby JM, Holloway GMN, Webb JK. A study of function after tibial cast bracing. Injury 1982-83, 14:432-9.

17. Haines JF, William EA, Hargadon ES. Is conservative treatment of tibial fractures justified? JBJS(Br) 1984;66-B:84-8.

18. Bruce French and Paul Tornetta. High energy tibial shaft fractures. Orthopaedic Clinics of North America. Vol 33(1):jan 2002;211-230.

19. Muller ME, Nazarion S, Koch P, Shatzker J. The comprehensive classification of fractures of long bones: Berlin etc, Springer Verlag, 1990.

20. Campbell's Operative orthopaedics 10th edition , 2003: volume 3, 2671-73, 2705, 2754-57, 2760.

21. Rockwood and Greens fractures in adults, 4th edition, 1996: volume 2, 2140-41, 2155-61.

22. Digby JM, Hollowary GMN, Webb JK. A study of function after tibial cast bracing. Injury 1982-83, 14:432-9.

23. Haines JF, William EA, Hargadon ES. Is conservative treatment of tibial fractures justified? JBJS(Br) 1984; 66-B:84-8.

24. Bruce French and Paul Tornetta. High energy tibial shaft fractures. Orthopaedic clinics of North America. Vol 33(1):jan 2002; 211-230.

25. Im GI, Tae SK. Distal metaphyseal fractures of tibia: a prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate and screws fixation. J Trauma. 2005 Nov; 59(5): 1219-23.

26. Bono CM, Levine RG, Rao JP, Behran FF. J Am Acad Orthop Surg 2001; may-jun; 9(3): 176-86.

27. Christoph Sommer. Biomechanics and clinical application principles of locking

plates. 20 Suomen Orthopedia Ja Traumatologia; vol 29:1. 2006.

28. Sommer C, Babit R, Muller M, Harson B. Locking compression plate loosening and plate breakage- A report of four cases. 2004, 18(8); 571-577.

29. Brown OL, Dirschi DR, Obremskey WT. Incidence of hardware – related pain and its effect on functional outcomes after open reduction and internal fixation of ankle fractures. J Orthop Trauma. 2001 may; 15(4): 271-4.

30. Textbook of orthopaedics and trauma, G S Kulkarni. 1st edition, 1999: volume 2: 1421,2150.

31. Bone LB, Johnson KD. Treatment of tibial fractures by reaming and intramedullary nailing. JBJS(Am) 1986;68-A:877-87.

32. Court Brown CM, Christie J, McQueen MM. Closed intramedullary tibial nailing: Its use in closed and type I open fractures. JBJS(Br) 1990;72-B:605-11.

33. Kretted C, Schandlmaier P Tscherne H. Nonreamed interlocking nailing of closed tibial fractures with severe soft tissue injury. Clin orthop 1995; 315:34-47.

34. Krettek C, Rudolf J, Schandelmaier P et al. Unreamed nailing of femoral shaft fractures: operative technique and early clinical experience with the standard

locking option. Injury 1996; 27:233-54.

35. Number Crancher Statistical System, Kaysville Utha. 2004. www.NCSS.com

36. Karstrom G, Olerud S. Fractures of tibial shaft, a clinical evaluation of treatment alternatives. Clin orthop 1974; 105:82-115.

37. Freedman EL, Johnson EE. Radiographic analysis of tibial fracture malalignment following intramedullary nailing. Clin Orthop Relat Res 1995 Jun; (315):25-33.

38. Ahler J, Von Issendorff WD. Incidence and causes of malalignment following tibial intramedullary nailing. Unfallchirurgie 1992; 18: 31-6.

39. Mosheiff R, Safran O, Segal D et al. The unreamed tibial nail in the treatment of distal metaphyseal fractures. Injury Feb 1999;30(2): 83-90.

40. Chen AL, Tejwari NC, Joseph TN et al. The effect of distal screw orientation on the intrinsic stability of a tibial intramedullary nail. Bull Hosp Joint Dis 2001; 60: 80-83.

41. Sean E Nork, Alexandra K, Schwartz et al. Intramedullary nailing of distal metaphyseal tibial fractures. JBJS(Am) 87 A-6, June 2005: 1213-1221.

42. Gorczyca JT, McKale J, Pugh K, Pienkowski D. Modified tibial nails for treating distal tibial fractures. J Orthop Trauma. 2002 Jan; 1691: 18-22.

# PROFORMA

## Use of fibular plating in addition to static intramedullary locking in distal third both bone fractures in leg

SI.No :

Patient name :

Age / Sex : IP.No :

Occupation :

Address :

Phone no :

---

Date of injury :

Mode of injury : Side : Right/Left

Fracture classification

AO :

Simple / compound ( Grade )

**FRACTURE PATTERN**

| | **Distance From Tibial Plateau / plafond** | **Length Of Fracture** | **Comminution** | **Preop Angulation Varus/ valgus Ante / Recurvatum** | **Post. Op** | **At union** |
|---|---|---|---|---|---|---|
| Distal 3rd | | | | | | |

Diameter of medullary canal

At isthmus

At the level of fracture

Distal metaphysis

Level of fibula fracture :

Associated injuries :

Interval between injury& surgery :

Reduction of TIBIA :

Nail Size :

No. of screws :

Proximal locking :

Distal locking :

Weight bearing started on :

Cast support :

Time for union :

Complication :

Secondary procedures :

Final outcome :

Karlstrom – Olierud Score ( 0-7 points ) :

Residual angulation ( 0-3 ) :

Fracture healing ( 0 - 3) :

Cast support ( 0 -1 ) :